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CLOSING PLENARY SESSION

Summary Thoughts About Sudden Cardiac Death

THOMAS N. JAMES, MD, FACC

Birmingham, Alabama

He maketh His sun to rise on the evil and the good, and sendeth rain on the just and the unjust.

Matthew 5:45
The Holy Bible
King James Version of 1611

During the 15th Bethesda Conference on the subject of sudden cardiac death, one of the recurring questions concerned the difference between the unlucky individual with certain elements of risk (for example, extensive coronary disease) who died suddenly and other people with similar or identical elements of risk who not only did not die suddenly, but who lived long and well. In addition to coronary disease, one can include left ventricular hypertrophy, cardioneuropathy and many other factors (Table 1) that introduce the same quandary: among any large number of people with seemingly the same visible or recognizable elements of risk, only a very small percent ever die suddenly. In essence, this is the numerator and denominator problem. Extensive study of those who die suddenly (the numerator) may reveal certain similarities, but without knowing how many others have exactly those same findings but who do not so die (the denominator), we can be misled as to the functional or operative significance of the similarities. Put in the simplest terms, we must face the likelihood that there are some and perhaps many other differences between the two groups that have not yet been recognized.

Contributory Factors in the Pathogenesis of Sudden Cardiac Death

In our discussions of contributing factors in the pathogenesis of sudden cardiac death, this Bethesda Conference examined a wide array of subjects. In his scholarly review about ventricular fibrillation, Surawicz discussed in great depth those many precursor events that so often precede the terminal event. Just as it may be misleading to think dogmatically that severe coronary disease "causes" sudden death rather than is found to be associated with it, it may be similarly misleading to think that ventricular fibrillation is in itself the principal target to attack. Understanding how multiple contributing factors eventually terminate in ventricular fibrillation provides us with a variety of other targets, most of which are more susceptible to favorable modification and even prevention.

Ventricular hypertrophy. Both Oparil and Brandenburg examined how cardiac enlargement is associated with an increased risk of sudden cardiac death, and they properly raised more questions than we can currently answer. If it is to be supposed that the hypertrophied heart can more easily be caused to fibrillate and is more difficult to defibrillate, what are the reasons for this and what is different about healthy individuals with similar degrees of cardiac enlargement (many athletes, for example) who do not fibrillate? Some obvious considerations are the role of interspersed foci of fibrosis, asymmetry or other inhomogeneity of arterial blood supply and possible distortions of neural distribution. Each of these three factors may contribute to disorganization of either excitation or recovery within the myocardium, thus favoring electrical instability. However, for ventricular hypertrophy very little is known about any one of these factors, either experimentally or in human patients.

Neural control of electrical stability of the heart. Among the influences that can most quickly and powerfully alter the electrical stability of the heart, its neural control must be placed high on the list. Both experimentally and clinically, it has long been known that appropriate vagal stimuli slow the heart and prolong atrioventricular (AV) conduction and that sympathetic stimuli do the opposite. Yet, as simple an observation as the structure of nerves and ganglia in the heart of a victim of sudden death has received pitifully little investigative attention; the exceptional observations of Rossi presented during this Conference should stimulate others to look for cardioneuropathy. From the functional standpoint, much of the session chaired and summarized by McIntosh dealt with this same issue. In that session, Shepherd and

From the Department of Medicine, University of Alabama Medical Center, Birmingham, Alabama.

Address for reprints: Thomas N. James, MD, Department of Medicine, University of Alabama Medical Center, University Station, Birmingham, Alabama 35294.

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Table 1. Partial Listing of Acute and Chronic Factors Known or Suspected to Participate in the Pathogenesis of Sudden Cardiac Death*

Acute Factors	Chronic Factors
Platelet aggregations	Left ventricular hypertrophy
Excitatory or inhibitory reflexes	Coronary atherosclerosis
Coronary spasm	Persistent fetal dispersion of AV node or His bundle, or both
Cardioneuropathy	Cardioneuropathy
Myocarditis	Myocarditis
Fright	Grief
Arteritis	Sustained hypertension
Sepsis	Infiltrative diseases (amyloid, hemachromatosis, sarcoid)
Coronary thrombosis	Focal fibrosis (scleroderma, chronic ischemia)
Acute myocardial infarction	Medications (by MD or other)
Acute focal ischemia	Endocrinopathies (thyroid, adrenal)
Acute hypertension	Long QT interval
Sudden hypotension	Malnutrition
Arrhythmias or heart block	Ethanol
Long QT interval	Tobacco smoking
Hypoxia	Small coronary disease
Acidosis or alkalosis	Diurnal rhythms
Ion imbalance (especially K^+, Ca^{++})	Climatic changes
Fever	Obesity
Dehydration	Valvular heart disease
Medications (by MD or other)	Cardiomyopathy
Ethanol	
Dysautonomia	
Physical stress	

*Not presented in any order of priority or known relative importance. Two or more of any of these factors are likely to coexist or to follow each other sequentially. Some factors exist as both acute and chronic influences.

Robertson discussed the crucial importance of cardiovascular reflexes and their likely contribution to electrical instability of the heart, Skinner dealt with events in the brain as they can be observed experimentally and Eliot reviewed the contributions of emotional stress in the pathogenesis of sudden cardiac death. Whether from the clinical or experimental vantage point, one is left with little doubt that more knowledge of how the nerves affect the heart and its electrical stability will help enormously in our understanding of sudden cardiac death. As the processes and events are more clearly defined, one can be optimistic that readily treatable and even preventable possibilities will emerge.

Coronary artery disease. None of us would deny that sudden cardiac death is a serious problem among those who have coronary disease. In patients with coronary disease, along with the responses caused by neural control of the heart, including its possible role in coronary spasm, one must also consider those events occurring within the blood and especially the platelets, as reviewed by Fuster. The magnitude of the problem is underscored by the fact that many individuals with coronary disease die suddenly without ever experiencing angina pectoris, a clinical dissociation discussed by Reeves, who has long been a student of the subject.

Some of those dying suddenly with coronary disease do have new myocardial infarction or new coronary thrombosis even without infarction. Although such deaths do not usually pose any special mystery, what of that larger number of individuals with a similar or identical infarct or coronary thrombus similarly located but who survived and continued to a normal convalescence? What is different about them? Furthermore, many of the victims of sudden death who have coronary disease of some degree do not have either myocardial infarction or any form of recent coronary obstruction. Was their terminal event some powerful neural stimulus, such as may occur with emotional stress, or an episode of coronary spasm, or a transient coronary obstruction that later disaggregated, or did they too have some yet unidentified factor to distinguish them from their living cohort?

Precursors of ventricular fibrillation. When there has been the opportunity to identify the terminal rhythm in victims of sudden cardiac death, it has most often been ventricular fibrillation. Surawicz emphasized the variety of important precursor events, and both Kubler and Opie examined several metabolic processes that participate in these precursor events. Additionally, *other* arrhythmias very often precede the final ventricular fibrillation and sometimes are the terminal event themselves. The special way in which atrial fibrillation may be fatal in patients with the Wolff-Parkinson-White syndrome was discussed by Meijler. Although patients with this special combination of circumstances may be rare, the implications for others who have

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atrial fibrillation (which is not a rare phenomenon) with intermittent changes in AV conduction may be more broadly important. Fisch and his colleagues McHenry and Armstrong collectively considered whether there are promising new opportunities from clinical electrocardiography (including its special applications during exercise or with prolonged recording). Their message was that the impressive array of technologic capabilities awaits more sharply defined questions to be asked. With better future understanding of all elements of the pathogenesis of electrical instability, even currently available electrocardiographic methods may provide rich new opportunities for predictive studies in patients. For certain particular arrhythmias, Bigger explained that specific pharmacologic treatment offers some promise in preventing sudden cardiac death. The other side of the coin is the growing recognition that some of these same treatments may themselves be arrhythmogenic.

At the more basic level, Fozzard discussed electromechanical dissociation, a known but rare cause of sudden cardiac death. But as with other fundamental issues, it is not the rarity or frequency of such events that would serve the main purpose of this conference, but a broader understanding of a known lethal process and its possible relevance in less "pure" examples. In a similar vein, Hoffman's review and that of Vassalle contribute to our understanding of how the normal electrical activity of the heart can become disorganized and, in that event, what the factors are that determine whether a survivable escape rhythm emerges.

Sudden death in infancy and childhood. In this Bethesda Conference, we were fortunate to have an entire session devoted to the matter of sudden death in infants, children and adolescents. For that purpose, McNamara organized reviews of the problem of crib death by Valdes-DaPena, of sudden death among children previously thought to be healthy by Driscoll, of death related to supraventricular arrhythmias by Gillette and of death related to ventricular arrhythmias by Garson. McNamara reported on a quarter century of experience from pediatric practice, describing his observations from 100 cases of sudden death. What emerged from these remarkable presentations was the wide spectrum of possible explanations, virtually none of which included coronary disease except in very rare examples of certain congenital anomalies. Furthermore, they and other students of the subject have found a growing number of sudden unexpected deaths occurring at long periods (often a decade or more) after hemodynamically successful cardiovascular surgery for various congenital malformations, a notable example being coarctation of the aorta. Sudden death in the young, a subject that has too seldom been examined this thoroughly in meetings on the general topic, is an indisputably important matter in its own right. But there is also a broader potential significance: that better understanding of the pathophysiology of sudden cardiac death in children may help unravel some of the mystery in adults. For example, if normal or abnormal variations in the structure of the cardiac conduction system emerge as an important matter in children who have no coronary disease, how often are the same structural abnormalities also present but rarely sought in adults who do have coronary disease?

Morphologic factors. Whether in adults or children, the morphologic substrate of sudden unexpected death must be sought more carefully. Examinations must be expanded beyond the usual and too often perfunctory search for abnormalities in the large coronary arteries. In the session dealing with some of the other morphologic factors (see pages 57B–80B and the summary on pages 81B–82B), the possible roles of ventricular hypertrophy (Oparil), intracardiac and extracardiac neural disease (Rossi) and variations both normal and abnormal in the cardiac conduction system (myself) were comprehensively reviewed. As previously emphasized, one or more of these factors usually coexist rather than appearing alone, and they very often are additionally associated with disease of the large coronary arteries or valvular lesions or similar problems that may correctly have been judged to be insufficient by themselves to cause sudden death. Instead of focusing on any one of these many factors at the expense of neglecting the others, the more appropriate emphasis must be on the importance of carefully evaluating *all* of them at every postmortem examination dealing with sudden death. As was stressed in several discussions by the audience, anything less must be considered an incomplete or inadequate study. In this context, any report of a "negative autopsy" in a case of sudden death is meaningless unless there is a careful description of just what was sought and what was not.

Epidemiologic or risk factors. So many reviews of the subject of sudden cardiac death are based on carefully conducted prospective or retrospective epidemiologic studies that there is sometimes the tendency to neglect other and possibly even more useful approaches. In this Conference, Kannel reported his findings about special subsets of sudden death observed in a very large population study. There are many valuable lessons from such observations. For example, few would quarrel with the recommendation for not smoking or not consuming too much ethanol. Epidemiologists and others concerned with public health in the broadest sense are heavily pressed by legislators and other public servants to present active plans for coping with all major health problems, among which sudden cardiac death is well known by newsmakers and other influential laymen. Responding to such well intended public pleas with the construction of programs aimed at preventing sudden death is often defended on the basis of an urgent need to do something even when our knowledge is incomplete and the certainty of outcome cannot be assured. But at least two matters must give us pause in this haste to be helpful. First, Oliver has properly emphasized the lack of impact (except in small selected groups) by any large program so far designed and

conducted in an effort to prevent sudden death. He has similarly discussed the troubling *new* risks sometimes introduced by efforts at risk factor reduction, again illustrating how important it is to be certain that proposed interventions are not themselves harmful. As more is learned about the basic factors responsible in the pathogenesis of sudden unexpected death, it can reasonably be expected that some of them may be eminently treatable or preventable by effective, inexpensive and safe means. However, we are a long way from that as yet.

Definition of sudden death. During this Bethesda Conference, no single definition of sudden death was imposed. Interestingly, during neither the planning sessions nor the meeting itself (including audience discussion) was the matter raised except in passing. There was no evidence that discussion was ever hampered or the value of the meeting in any way diminished by the absence of a restrictive definition, of the type mandatory for epidemiologic or other large group studies. Any clear and reasonable definition of sudden death was judged to be acceptable, and no committee veto was exercised. There are valuable lessons to be learned through a broad variety of legitimate and clear definitions of sudden death, whether witnessed or not, whether instantaneous or more prolonged, whether expected or unexpected, whether in the presence of known or suspected heart disease or not, whether in human beings or animals and at any age and in any country. To exclude any of these categories would diminish without question our opportunity to reach the fullest understanding we can.

Oddly, the lay public, news reporters and most physicians have little or no problem understanding what is meant by sudden death. It is only when disputatious scientists enter the debate (or create it) that the subject becomes muddied. The intentions may all be very well, but the result is too often confusion rather than clarity.

Role of the Bethesda Conference

Traditionally, the Bethesda Conferences are intended to produce a consensus view of the chosen subject by utilizing the Delphi plan, leading to an ordering of options and priorities. For most subjects that is difficult, and those organizing the 15th Bethesda Conference were well aware of the special problems our subject presented for that purpose. For our task, it would be arguable whether we could meaningfully derive any consensus by the usual democratic process of voting for or against a lengthy catalog of explicit points or questions. In the summary you are now reading, consensus is to be interpreted as the conscientious best effort of a rapporteur describing what he heard and read and doing it with every intent of objectivity and fairness to all views. In any way which this may have failed, I beg the indulgence of the reader, knowing that those who have themselves faced this kind of responsibility will especially understand my dilemma.

It is to be hoped that the results of the 15th Bethesda Conference can be found useful by a variety of organizations, institutions and constituencies. Among physicians, we hope that cardiologists, epidemiologists, internists and all caring for those at risk, who constitute a large but ill defined pool of patients, will find matters worthy of their attention. For basic and clinical scientists, we hope some intellectual challenges emerge. For the public and its servant the government with all its branches, a better understanding of sudden cardiac death will, it is hoped, enlist their support for work needing to be done. Those in pharmaceutical and medical instrument industries may find new leads or elements of practical value. Evaluators of individuals for whom sudden death may introduce public hazard (for example, bus or truck drivers or airline pilots) may gain some understanding of the problem even though we have furnished very few dependable yardsticks for their task.

From modern meetings similar to this Bethesda Conference, there is often an ill defined but uncontrollable urge to recommend another symposium, new and larger and more comprehensive clinical trials or massive examinations of populations here and abroad. Each of these approaches unquestionably has some merit, as attested to by numerous previous recommendations from other meetings about sudden death. Each of them is also unquestionably expensive, as the history of each has amply demonstrated, although I am not persuaded that this need be the case.

As a corollary consideration, it is necessary to deal with the matter of cost-effectiveness. Although an obsessive concern with this matter has almost become a cliché, it is nevertheless an inescapable problem in the face of reality. All forms of research on the pathogenesis of sudden cardiac death must be encouraged if its prevention is ever to be realized. The cumulative historical experience with true prevention, as contrasted to partial or debatably effective prevention (the "half-way technology" of Lewis Thomas), teaches us that the best basis for truly effective treatment *or* prevention is a detailed understanding of pathogenesis. Anything short of that, based on assumptions and partial truths, will too often end in frustration and disappointment.

Recommended Areas for Future Research

Owing in large measure to our continuing ignorance about the pathogenesis of sudden cardiac death, there is little which can be predicted to be successful for programs of prevention except in small selected groups. For the broader overall problem of sudden cardiac death, what is urgently needed is more knowledge about its pathogenesis. An identical conclusion was derived at another very recent meeting which examined the problem of sudden cardiac death veiwed in

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its global context (1). That means expanded programs of fundamental research. The following suggestions are offered on the basis of this Conference:

I. Coronary artery disease. In the very large number of patients with coronary disease who die suddenly and unexpectedly, there are many questions ripe for study. One of the most important needs is to determine the difference between those who die suddenly and the much larger group of other individuals—with similar coronary disease, with or without coronary thrombosis or myocardial infarction—who survive a long time. Comparative postmortem studies could include those with appropriately similar severity of coronary disease, but who die of other causes such as stroke or various accidents. In such comparisons, particular attention should be directed to the presence or absence of myocardial hypertrophy, the condition of the cardiac conduction system and the state of the cardiac nerves and ganglia. Each of these, alone or in various combinations, is particularly capable of unstabilizing the electrical activity of the heart and merits special attention in the study of sudden death with or without associated coronary disease. Furthermore, there are many new methods being developed to assess these factors in living individuals, and appropriate examinations for this purpose should especially be done among those recognized to be at risk of sudden death.

II. Sudden cardiac death in children. Although there must be many differences in the pathogenesis of sudden cardiac death in children as compared with adults, the most obvious one being the prevalence of coronary disease among the latter, there may also be many factors that are similar or even the same. Some effort should be directed to defining what these differences are and what the similarities may be. As one heuristic hypothesis, perhaps the explanation of why some adults with severe coronary disease die quickly, but the great majority do not, resides in some undefined difference that has nothing or very little to do with the coronary disease. It may even be an abnormality in the heart or elsewhere which is the same as what is present in children.

III. Late postoperative sudden death. Another example of an overlapping question applicable to both the young and the old is why late postoperative sudden death occurs in patients with congenital heart disease. It is a challenge to understand why either a child or an older person with successfully corrected coarctation of the aorta should suddenly and unexpectedly die 5 or 10 or more years later. This does not refer to those patients with ruptured berry aneurysm or bicuspid aortic valves, both of which are sometimes associated with coarctation; rather it refers to individuals who presumably have a terminal cardiac arrhythmia as the primary problem. Some new attention has already begun to focus on this question, but more is needed.

IV. Left ventricular hypertrophy. One of the recurring subjects of discussion during this conference was the impressive association of left ventricular hypertrophy (or any cardiac enlargement) with sudden unexpected death, even in the absence of any other recognized problem. Put in epidemiologic terms, left ventricular hypertrophy is a powerful independent marker of risk for sudden death. Here it is important to be reminded that abnormalities of the cardiac nerves or ganglia, of the conduction system or of small arteries in the heart (which include coronary anastomoses as well as the nutrient circulation of the conduction system) may be associated with ventricular hypertrophy but are seldom adequately sought. We also need to know whether the hypertrophied ventricle was or was not focally fibrotic, how such abnormalities may have been distributed, what the electrophysiologic significance of this may have been, whether the capillary and arteriolar distribution was appropriate and all related changes that would be expected to make the patient with ventricular hypertrophy more vulnerable to electrical instability.

V. Neural control of the heart. Separate research by neurophysiologists, psychiatrists, cardiovascular physiologists, pathologists and cardiologists has begun to draw attention to the powerful influence of neural control of the heart. There has been some (but insufficient) effort to synthesize or organize this rapidly growing body of knowledge and relate it to lethal electrical instability of the heart. It is not a unique problem in scientific communication, but one which may be judged as potentially opening highly promising new approaches to effective treatment or prevention of factors predisposing to sudden death. Powerful new drugs influencing neural activity either in the brain or peripherally are already widely utilized, sometimes with unanticipated and regrettable results. If the general subject could be viewed collectively from these various perspectives, those same drugs could perhaps be more safely and effectively employed and new analogs could be planned for other specific purposes. Most of us intuitively believe that control of emotional stress would be beneficial, but our rationale would improve with a more objective basis and programs of treatment could be more accurately designed. The reflexes that have been so carefully investigated by physiologists may have far greater relevance for the practicing cardiologist than is now realized, and their variety and interplay with each other and with the activity of the brain itself form a research field fallow for harvest. In any consideration of the pathogenesis of sudden death, almost every contributing step can become remarkably distorted if focal disease of the cardiac nerves or ganglia is present, but cardioneuropathy and extracardiac neural disease are rarely included in postmortem examinations in cases of sudden death. Cardioneuropathy has its own importance, but it is compounded when coronary disease or ventricular hypertrophy, or both, is also present.

Better methods and their wider use for clinical evaluation of autonomic neural control are badly needed. For application to many individuals, but particularly to those known

for one reason or another to be at higher than usual risk for sudden cardiac death, such methods should be safe, inexpensive and easily performed. Changes in cardiac rhythm or conduction or in the level of blood pressure which are caused by autonomic neural events may be among the most readily defined and easily treatable predisposing factors. However, it should also be recognized that autonomic neural responsiveness even in the same individual may change extensively from one time to another (for example, during sleep, after meals or during emotional stress).

VI. Morphology of cardiac conduction system. As one who has spent much of his professional life examining the morphology of the cardiac conduction system, I find it sad to see so few others interested in the subject. Notable exceptions to this generalization include several participants in this Conference, both as speakers and audience, but there are too few of us for what needs to be done. Optimally, either pathologists with a special interest in the heart and its electrical activity or cardiologists with a similar interest in anatomy and pathology would be preferable to a team approach by separate individuals in which cross-interests are too often not effectively shared. To my knowledge, no formal effort has been mounted to convene the few actively working in the field with the aim of developing plans to bring others into the fold. Perhaps this would be useful for better understanding of how sudden death occurs.

VII. Sudden death in animals. Just as valuable lessons about sudden death in adults may be derived from research into the pathogenesis of sudden death among children, we could learn much from a more careful investigation of sudden death in other animals. The sudden unexpected loss of a prize dog or valuable horse is always newsworthy, but it is also an opportunity for more effective research than is usually conducted. Scientific exploitation of the opportunity to learn from rare examples should also include those special forms of sudden unexpected death known to occur in widely scattered regions of the world, that is, what could be termed *geographic examples of sudden death*. Some effort to examine this latter possibility would merit consideration by the World Health Organization and similar international organizations.

VIII. Clinical history. Too little is known of the clinical history of victims of sudden unexpected death, and there has been little systematic effort to improve this. Such a rich source of information merits attention especially among those who died with no recognized cardiac disease, but no less for those with coronary disease who had no infarct or thrombosis. The family history, the life style of the deceased, eating and drinking habits, detailed cataloging of self-prescribed or administered medications or drugs, patterns of physical activity or inactivity, any associated recent changes in temperature or climate, emotional status and similar factors are rarely sought except for news reports or rote completion of forms. Yet, it would cost little and possibly provide a great deal of value if such information was routinely sought in some considerate and ethically sensitive fashion.

IX. Toxicologic studies. As a corollary to obtaining better clinical histories in victims of sudden cardiac death, there is a need for more systematic and comprehensive postmortem toxicologic studies. In some jurisdictions, the coroner or medical examiner is required to conduct such examinations, but one cannot be certain about the consistency of accurate or dependable results even in such jurisdictions. Additionally, too few places require any studies of this type. A broader screen of chemical determinations should include not only known or suspected agents such as narcotics, sedatives and tranquilizers, but many other compounds such as those with known cardioactive properties. Initially, a more comprehensive program of this type (to include standardizing laboratories or even one central facility) would be more costly than the ultimate program should require. But as a research effort with considerable promise for valuable information, it merits careful consideration.

X. Myocardial membrane transport or permeability. Better understanding of membrane transport or permeability and the metabolic processes that govern them can improve our prospects of explaining how electrical instability of the heart begins. For this purpose, it is impractical to expect that direct myocardial studies will often be possible in human beings, and such studies of the conduction system can hardly include biopsy specimens from it. However, samples of myocardium obtained during cardiac surgery or in cases where biopsies of the heart are otherwise indicated may be a valuable source for such information. Furthermore, removal of blood corpuscles (red or white) or platelets is a simple and inexpensive source for correlative research for this purpose. Other tissue such as adipocytes may also be considered.

XI. Secular trends of both coronary disease and sudden cardiac death. These require better definition and understanding. There is now some evidence that the steady decrease in death from coronary disease is not associated with any discernible difference in either the incidence or severity of coronary disease (2). Among the several possible explanations for such a dissociation, one must consider the possibility that the primary trigger or precipitating final event has little or perhaps nothing to do with the coronary disease itself, although it is most logical to accept that the more severe examples of coronary disease are a contributing factor in the magnitude of risk from any other unstabilizing influence on the electrical activity of the heart. Better criteria should be developed on which to decide whether a given example of sudden cardiac death should be validly attributed to coronary disease that may be present, particularly in those cases where neither myocardial infarction nor coronary thrombotic occlusion was found.

XII. Elements of chance. At another time I wrote of the elements of chance that are intrinsic in the pathogenesis

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of sudden cardiac death (3). Nothing reported or discussed in this Conference has lessened the importance of appreciating how the integration of many separate factors, most often largely by chance, can lead to lethal electrical instability of the heart. But the essentiality of chance in many or most instances of sudden death must not be misconstrued as espousing nihilism, nor even any need for pessimism. On the contrary, it is only when each of the contributing elements is more clearly recognized and defined, and the basis of its participating contribution explained, that we can hope to develop means of either preventing or treating any or all of these elements. In the meantime, if we overinterpret one or the other of these (for example, ventricular hypertrophy, coronary disease or cardioneuropathy), it will be to the detriment of a true understanding of how sudden death happens.

An appreciation of how chance participates in the pathogenesis of sudden cardiac death can help us define the wide variety of ways in which it may occur, sort out which of the multiple factors is or is not amenable to treatment or prevention, explain how one factor may worsen the influence of another but alleviate that of a third and improve our prospects of accurately assessing the likely cost-effectiveness and clinical benefit of any proposed intervention. Accepting the role of chance would encourage an open-mindedness about the large variety of factors that must be included in the eventual catalog.

References

1. Report of a WHO Scientific Group on Sudden Cardiac Death. WHO Technical Report Series (in press).
2. Elveback L, Lie JT. Continued high incidence of coronary artery disease in autopsy in Olmsted County, Minnesota, 1950 to 1979. Circulation 1984;70:345–9.
3. James TN. Chance and sudden death. J Am Coll Cardiol 1983;1:164–83.